Parker
FluidConnectors

Metric Tubing

The Fitting Authority

General recommendations for tubes

1. Steel types, mechanical properties, conditions

Steel type	Tensile strength	Yield point	Ductile yield A5 (elongation)	Condition
Fine grain quality (RR) St. 37.4 per DIN 1630	340 N/mm^2 min. 49,000 lb/in^2	235 N/mm^2 min. 34,000 lb/in^2	25% min.	Seamless, cold drawn under inert gas, normal annealed abbreviation NBK DIN 2391C, Part 2

Table M1 — Steel types, mechanical properties and conditions of EO steel tubes

Steel type	Tensile strength	Yield point	Ductile yield A5 (elongation)	Condition
Abbreviation 1.4571 X6CrNiMoTi17122	500 N/mm^2 min. 72,500 lb/in^2	245 N/mm^2 min. 35,500 lb/in^2	35% min.	Seamless, cold drawn free of scale, heat-treated in accor. with DIN 17458 tab. 6
Abbreviation 1.4541 X6CrNiTi810	500 N/mm^2 min. 72,500 lb/in^2	235 N/mm^2 min. 34,000 lb/in^2	35% min.	

Table M2 — Steel types, mechanical properties and conditions of EO stainless steel tubes

2. Tests and certifications

All tubes are subjected to a non-destructive leak test and marked accordingly as proof. This marking replaces a works certificate DIN 50 049-2.2. Test class 1 DIN 17458 Table M2 applies for tubes made of 1.4571 and 1.4541.

3. Recommended bend radii

A bend radius of 3x the external tube diameter is recommended for cold bending of tubes with tube benders or by hand.

4. Welding suitability and weldability

Tubes of St 37.4 are weldable according to usual techniques. Types made of 1.4571 and 1.4541 (stainless) are suitable for arc welding. The welding filler should be selected in accordance with DIN 8556 part 1 taking into account the type of application and the welding technique.

5. Approximate calculation of the flow resistance in straight tubelines

The flow resistance and thus the tubeline efficiency is influenced by the tube diameter, the volume flow (measured or calculated) and the properties of the medium. Laminar flow should be considered in order to keep losses in the system down to a minimum. The transition from laminar to turbulent flow, which brings an increase in the flow resistance is generally defined by the Reynolds number Re 2320. Since the transition cannot be pinpointed exactly, the transition range can only be determined by measuring. If, for simplified calculation, transition at Re 2320 and a “technically smooth” tube inner surface are assumed, the limit speeds w crit. and the laminar to turbulent flow volume flow ν crit. when transition takes place, can be estimated according to the following formulae:

$$w_{crit.} = \frac{2.32 \cdot \nu}{d_i} \quad [m/s]$$

$$\mathring{v}_{crit.} = 0.109 \cdot d_i \cdot \nu \; [l/min]$$

d_i = tube bore Ø in mm

ν = kinematic viscosity in mm²/s.

For approximate calculation of the pressure drop in bar/1m tube length, the following formulas can be used:

1. Laminar range:

$$\rho_v = \frac{0.32 \cdot w \cdot \nu \cdot \rho}{d_i^2 \cdot 10^3} = \frac{6.79 \cdot \mathring{v} \cdot \nu \cdot \rho}{d_i^4 \cdot 10^3} \; [bar/1m]$$

2. Turbulent range:

$$\rho_v = \frac{0.281 \cdot w^{1.75} \cdot \nu^{0.25} \cdot \rho}{d_i^{1.25} \cdot 10^3} =$$

$$= \frac{59 \cdot \mathring{v}^{1.75} \cdot \nu^{0.25} \cdot \rho}{d_i^{4.75} \cdot 10^3} \; [bar/1m]$$

w = flow speed in m/s; ν = kinetic viscosity in mm²/s; $\mathring{v}$ = volume flow in l/min.; ρ = density of the medium in kg/m³; d_i = pipe internal diameter in mm.

Detailed calculations of the flow resistance require an exact knowledge of the tubeline system and the operating conditions. Refer to the relevant literature for other methods of calculations.

M

Seamless EO steel tubes

Material St. 37.4

St. 37.4 Phosphated & Oiled Part No.	St. 37.4 Zinc Plated & Yellow Chromate Part No.	Tube O.D (mm)		Toler-ance	Wall thickness (mm)	Tube I.D. (mm)	Design pressure bar DIN 2413 I Static	Design pressure bar DIN 2413 III Dynamic	Burst pressure bar	Weight kg/m
R04x0.5		4	•		0.5	3	313	274	1160	0.047
R04x0.75		4		±0.1	0.75	2.5	409	393	1820	0.063
R04x1	R04x1 VZ	4	•		1	2	522	502	2850	0.074
R05x1	R05x1 VZ	5		±0.1	1	3	432	416	2120	0.099
R06x0.75		6			0.75*	4.5	333	289	1230	0.103
R06x1	R06x1 VZ	6	•		1	4	389	374	1680	0.123
R06x1.5	R06x1.5 VZ	6	•	±0.1	1.5	3	549	528	3050	0.166
R06x2		6	•		2	2	692	665		0.197
R06x2.25		6			2.25	1.5	757	728		0.208
R08x1	R08x1 VZ	8	•		1	6	333	289	1190	0.172
R08x1.5	R08x1.5 VZ	8	•	±0.1	1.5	5	431	414	1860	0.240
R08x2	R08x2 VZ	8	•		2	4	549	528	3020	0.296
R08x2.5		8			2.5	3	658	632		0.339
R10x1	R10x1 VZ	10	•		1	8	282	249	870	0.222
R10x1.5	R10x1.5 VZ	10	•		1.5	7	373	358	1380	0.314
R10x2	R10x2 VZ	10	•	±0.1	2	6	478	460	2100	0.395
R10x2.5		10			2.5	5	576	553	3180	0.462
R10x3		10	•		3	4	666	641		0.518
R12x1	R12x1 VZ	12	•		1	10	235	210	760	0.271
R12x1.5	R12x1.5 VZ	12	•		1.5	9	353	305	1150	0.388
R12x2	R12x2 VZ	12	•	±0.08	2	8	409	393	1580	0.493
R12x2.5		12	•		2.5	7	495	476	2600	0.586
R12x3		12			3	6	576	553	3200	0.666
R12x3.5		12			3.5	5	651	627		0.734
R14x1		14			1*	12	201	182	620	0.321
R14x1.5		14	•		1.5	11	302	265	940	0.462
R14x2	R14x2 VZ	14	•		2	10	403	343	1340	0.592
R14x2.5		14		±0.08	2.5	9	434	417	1760	0.709
R14x3		14			3	8	507	487	2400	0.814
R14x3.5		14			3.5	7	576	553	3220	0.906
R14x4		14			4	6	641	616		0.986
R15x1	R15x1 VZ	15	•		1*	13	188	171	590	0.345
R15x1.5	R15x1.5 VZ	15	•		1.5	12	282	249	980	0.499
R15x2	R15x2 VZ	15	•	±0.08	2	11	376	323	1250	0.641
R15x2.5		15			2.5	10	409	393	1690	0.771
R15x3		15			3	9	478	460	2120	0.888
R16x1		16			1*	14	176	160	540	0.370
R16x1.5	R16x1.5 VZ	16	•		1.5	13	264	234	820	0.536
R16x2	R16x2 VZ	16	•	±0.08	2	12	353	305	1170	0.691
R16x2.5	R16x2.5 VZ	16	•		2.5	11	386	372	1470	0.832
R16x3	R16x3 VZ	16	•		3	10	452	435	1920	0.962
R18x1		18	•		1*	16	157	143	510	0.419
R18x1.5	R18x1.5 VZ	18	•		1.5	15	235	210	780	0.610
R18x2	R18x2 VZ	18	•	±0.08	2	14	313	274	1040	0.789
R18x2.5		18	•		2.5	13	392	335	1320	0.956
R18x3		18			3	12	409	393	1830	1.111

● Denotes standard from stock

* Tubes which need a support sleeve (VH) for assembly in EO and EO-2 fittings.

Table M3 — Seamless EO steel tubes

Pressure Calculations:

Calculation pressures given are according to DIN 2413 Part 1 for **static stress**

$$P = \frac{20 \bullet K \bullet s \bullet c}{S \bullet d_a} \text{ (bar)}$$

Material characteristic value K=235N/mm²

and

DIN 2413 part III for **dynamic stress**

$$P = \frac{20 \bullet K \bullet s \bullet c}{S \bullet (da + s \bullet c)} \text{ (bar)}$$

Material characteristic value K=226 N/mm² (permanent fatigue strength)

Safety correction value S=1.5 for static and dynamic stress.

Factor “c” for consideration of wall thickness divergence **for static and dynamic stress** =0.8 for tube o.d. 4 and 5; 0.85 for tube o.d. 6 and 8; 0.9 for larger tube o.d.

d_a = Tube O.D. in mm

s = Wall thickness in mm

Standard Tube Length:

- 6m (19.7 ft.)

Conversion Factors:

- Bar x 14.5 = psig
- kg/m x 0.672 = lbs/ft
- N/mm² x 145 = lb/in²

See Remarks on page M5.

Seamless EO steel tubes (Continued)

Material St. 37.4

St. 37.4 Phosphated & Oiled Part No.	St. 37.4 Zinc Plated & Yellow Chromate Part No.	Tube O.D (mm)		Toler-ance	Wall thickness (mm)	Tube I.D. (mm)	Design pressure bar DIN 2413 I Static	Design pressure bar DIN 2413 III Dynamic	Burst pressure bar	Weight kg/m
R20x1.5		20	•		1.5*	17	212	191	570	0.684
R20x2	**R20x2 VZ**	20	•		2	16	282	249	920	0.888
R20x2.5	**R20x2.5 VZ**	20	•	±0.08	2.5	15	353	305	1220	1.079
R20x3	**R20x3 VZ**	20	•		3	14	373	358	1450	1.258
R20x3.5		20			3.5	13	426	410	1720	1.424
R20x4		20	•		4	12	478	460	2080	1.578
R22x1.5	**R22x1.5 VZ**	22	•		1.5	19	192	174	590	0.758
R22x2	**R22x2 VZ**	22	•	±0.08	2	18	256	228	850	0.986
R22x2.5		22	•		2.5	17	320	280	1040	1.202
R22x3		22			3	16	385	329		1.406
R25x2	**R25x2 VZ**	25	•		2	21	226	202	670	1.134
R25x2.5	**R25x2.5 VZ**	25	•		2.5	20	282	249	920	1.387
R25x3	**R25x3 VZ**	25	•	±0.08	3	19	338	294	1050	1.628
R25x4		25	•		4	17	394	379	1520	2.072
R25x4.5		25			4.5	16	437	420	1780	2.275
R25x5		25			5	15	478	460	2120	2.466
R28x1.5		28			1.5	25	151	139	450	0.980
R28x2	**R28x2 VZ**	28	•		2	24	201	182	620	1.282
R28x2.5		28	•	±0.08	2.5	23	252	224	770	1.572
R28x3		28	•		3	22	302	265	920	1.850
R28x4		28			4	20	403	343		2.368
R28x5		28			5	18	434	417		2.836
R30x2		30	•		2*	26	188	171	620	1.381
R30x2.5		30	•		2.5	25	235	210	770	1.695
R30x3	**R30x3 VZ**	30	•	±0.08	3	24	282	249	920	1.998
R30x4	**R30x4 VZ**	30	•		4	22	376	323	1250	2.565
R30x5		30			5	20	409	393	1580	3.083
R35x2	**R35x2 VZ**	35	•		2	31	161	147	470	1.628
R35x2.5		35			2.5	30	201	182	620	2.004
R35x3	**R35x3 VZ**	35	•	±0.15	3	29	242	216	720	2.367
R35x4		35	•		4	27	322	281	960	3.058
R35x5		35			5	25	403	343		3.699
R35x6		35			6	23	419	403		4.291
R38x2.5		38			2.5*	33	186	168	550	2.189
R38x3		38	•		3	32	223	200	660	2.589
R38x4	**R38x4 VZ**	38	•	±0.15	4	30	297	261	970	3.354
R38x5	**R38x5 VZ**	38	•		5	28	371	319	1350	4.069
R38x6		38	•		6	26	390	375		4.735
R38x7		38	•		7	24	446	429		5.352
R42x2	**R42x2 VZ**	42	•		2*	38	134	124	390	1.973
R42x3	**R42x3 VZ**	42	•	±0.2	3	36	201	182	580	2.885
R42x4		42	•		4	34	269	238	850	3.749
R50x6		50		±0.2	6	38	338			6.511
R50x9		50			9	32	437			9.100
R65x8		65		±0.3	8	49	347			11.246
R80x10		80		±0.35	10	60	353			17.263

• Denotes standard from stock
* Tubes which need a support sleeve (VH) for assembly in EO and EO-2 fittings.

Table M3 — Seamless EO steel tubes (Continued)

Remarks:

Corrosion — Additional allowances are not considered for the calculation of pressures.

Tube with a diameter ratio of $\frac{da}{di\ max.} \geq 1.35$ are calculated for **static stress** in accordance with DIN 2413 Part III, but with $K = 235N/mm^2$.

When a specific factor of safety is required, calculations should be based upon the burst pressures shown in the above tables.

Temperature range: -40°C up to 120°C with-out pressure reductions.

Surface finish:

Tubes with I.D. 1.5 to 5 mm: outside and inside oiled.

Tubes from 6 mm I.D. and above: outside and inside phosphated and oiled.

M

Seamless EO stainless steel tubes Material-No.: 1.4571/1.4541

Part No.	Tube O.D. (mm)		Toler-ance	Wall thickness (mm)	Tube I.D. (mm)	1.4571 Design pressure bar DIN 2413-1 Static	1.4541 Design pressure bar DIN 2413-1 Static	1.4571 burst pressure bar	Weight kg/m
R06x171	† 6	•	±0.1	1	4	426	409	2340	0.125
R08x171	† 8	•	±0.1	1	6	368	353	1660	0.175
R08x1.571	8	•		1.5	5	472	452	2800	0.244
R10x171	† 10	•		1	8	294	282	1290	0.225
R10x1.571	† 10	•	±0.1	1.5	7	389	373	1930	0.319
R10x271	10	•		2	6	498	478	3100	0.401
R12x171	† 12	•		1	10	245	235	1220	0.275
R12x1.571	† 12	•	±0.08	1.5	9	368	353	1580	0.394
R12x271	12	•		2	8	426	409	2380	0.501
R14x1.571	14	•		1.5	11	315	302	1550	0.469
R14x271	14	•	±0.08	2	10	420	403	2180	0.601
R14x2.571	14			2.5	9	452	434	2800	0.720
R15x171	15	•		1*	13	196	188	860	0.351
R15x1.571	† 15	•	±0.08	1.5	12	294	282	1140	0.507
R15x271	15			2	11	392	376	1750	0.651
R16x271	† 16	•		2	12	368	353	1800	0.701
R16x2.571	16		±0.08	2.5	11	403	386	2120	0.845
R16x371	16			3	10	472	452	2800	0.977
R18x1.571	† 18	•	±0.08	1.5	15	245	235	1050	0.620
R18x271	18	•		2	14	327	313	1520	0.801
R20x271	† 20	•		2	16	294	282	1250	0.901
R20x2.571	20		±0.08	2.5	15	368	353	1550	1.095
R20x371	20	•		3	14	389	373	1960	1.277
R22x1.571	† 22	•	±0.08	1.5	19	200	192	720	0.770
R22x271	22	•		2	18	267	256	1020	1.002
R25x2.571	† 25	•	±0.08	2.5	20	294	282	1190	1.408
R25x371	25			3	19	353	338	1520	1.653
R28x1.571	28		±0.08	1.5	25	158	151	620	0.995
R28x271	† 28	•		2	24	210	201	880	1.302
R30x371	30		±0.08	3	24	294	282	1140	2.028
R30x471	† 30	•		4	22	392	376	1650	2.605
R35x271	35	•	±0.15	2	31	168	161	670	1.653
R38x471	38		±0.15	4	30	309	297	1240	3.405
R38x571	38			5	28	387	371	1680	4.131
R42x271	42	•	±0.2	2*	38	140	134	520	2.003
R42x371	42			3	36	210	201	860	2.930

• Denotes standard from stock
† Standard range for tubes of material no. **1.4541**
* Tubes which need a support sleeve (VH) for assembly in EO and EO-2 fittings.

Table M4 — Seamless EO stainless steel tubes

Pressure Calculation

Pressure calculation given are according to DIN 2413 part I for **static stress**

$$P = \frac{20 \bullet K \bullet s \bullet c}{S \bullet d_a} \text{ (bar)}$$

Material characteristic value K=245 N/mm² (1.4571), K=235 N/mm² (1.4541) (1% proof stress)

Safety factor S = 1.5

Factor “c” for consideration of wall thickness divergence: 0.9

d_a = Tube O.D. in mm

s = Wall thickness in mm

Remarks

Corrosion — Additional allowances are not considered for the calculation of pressures.

Tubes with a diameter ratio da/di ≥ 1.35 are calculated according to DIN 2413 part III (formula, see page M3) with above characteristic K value.

Conversion Factors:

- Bar x 14.5 = psig
- kg/m x 0.672 = lbs/ft
- N/mm² x 145 = lb/in²

Seamless EO stainless steel tubes Material-No.: 1.4571/1.4541

For range of application for which a certain safety compared to burst pressure is demanded for tubes of 1.4571, the measured burst pressures are contained in tube-tables. Burst pressure values for tubes of 1.4541 are not available at present.

Pressures according to DIN 2413 port III for **dynamic stress** are not listed, because in DIN 17458 the permanent fatigue stress is also not listed. Up to standard gauge localization of permanent fatigue strength we recommend, for calculations to use DIN 2413 part III (formula, see page M3), the use of following characteristic value:

permanent fatigue strength K=190 N/mm² for tubes of 1.4571 and 1.4541; S=1.5; C=0.9.

Permissible temperature range and required pressure reductions. This is based on calculated pressures at the elevated temperatures shown, taking into consideration the recommended reduction in proof stress (DIN 17458).

Temperature		- 60° up to +20° C	50°C	100°C	200°C	300°C	400°C
Pressure reductions in %	1.4571	-	4.5	11	20	29	33
	1.4541	-	5.5	11.5	21.5	29	34

Interpolation is acceptable for intermediate temperature levels.

Support sleeves (VH):

Sizes which need support sleeves for assembly. See Figures H4a and H4b on page H13.

Click Here
to Go to the First Page
of the Next Section

M